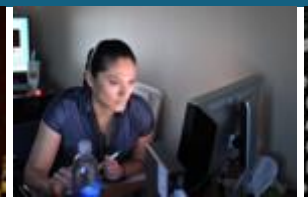
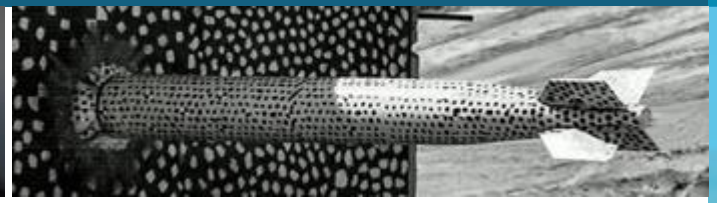
April 23, 2022

A Sandia Career





For the The AIChE Rocky Mountain student conference 2022
University of New Mexico

Dr. Alexander L. Brown; albrown@sandia.gov; (505)844-1008

Fire Science and Technology Department

Fire Science & Technology

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2022-????

Part 1: About Sandia

SANDIA'S HISTORY IS TRACED TO THE MANHATTAN PROJECT

THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Tele
195 Broadway,
New York 7, N. Y.

- July 1945: Los Alamos creates Z Division
- Nonnuclear component engineering
- November 1, 1949: Sandia Laboratory established
- AT&T: 1949–1993
- Martin Marietta: 1993–1995
- Lockheed Martin: 1995–2017
- Honeywell: 2017–present

SANDIA IS A FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER(FFRDC) MANAGED AND OPERATED BY

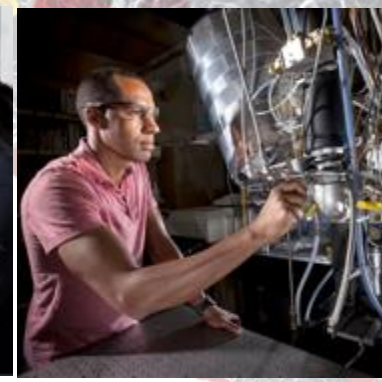
National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc.

Government owned, contractor operated

FFRDCs are long-term strategic partners to the federal government, operating in the public interest with objectivity and independence and maintaining core competencies in missions of national significance

NATIONAL SECURITY IS OUR BUSINESS

For more than 70 years, Sandia has delivered essential science and technology to address the nation's most challenging security issues



PURPOSE Render exceptional service in the national interest

VISION To be a leader in keeping the world safe and secure

MISSION We use innovative science and engineering to anticipate and solve the most challenging national security problems.

SANDIA HAS FIVE MAJOR PROGRAM PORTFOLIOS

Sandia National Labs Facts

People Sandia's staff of about **15,000** includes more than 7,441 with advanced degrees.

Sandia people work at:

- The laboratories' Sandia National Laboratories head-quarters in Albuquerque, New Mexico
- A second lab in Livermore, California
- Other sites including Carlsbad, New Mexico; Las Vegas and Tonopah, Nevada; Amarillo, Texas; and Kauai, Hawaii.

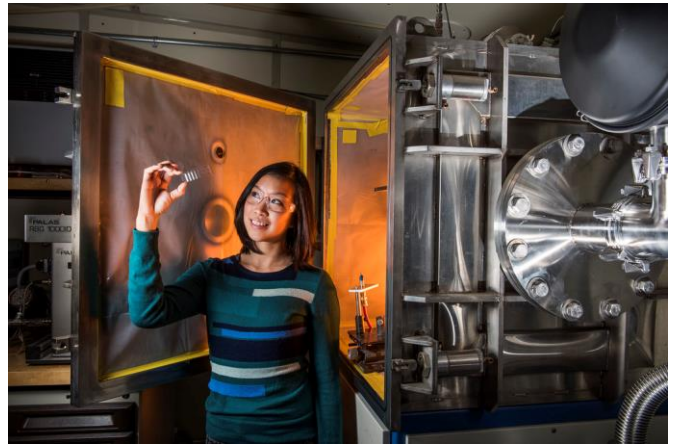
Budget

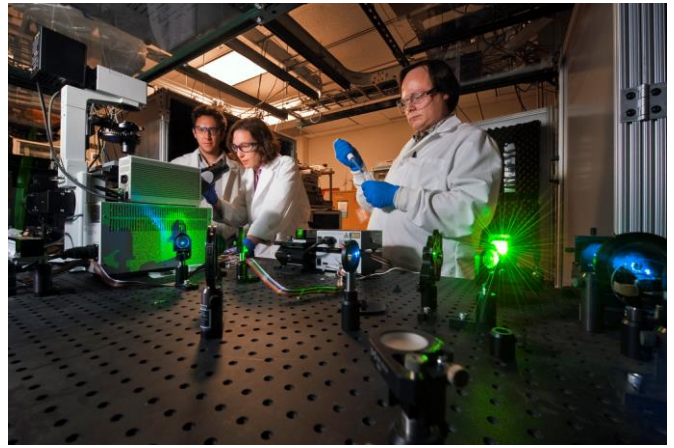
- Sandia's operating costs were about $3.9 billion in fiscal year 2021.

Sandia will help the nation solve significant problems with core capabilities in:

- Systems engineering and integration
- High-performance computing, as well as modeling and simulation
- Extreme-environment testing at unique facilities
- Nanotechnologies and microsystems

Sandia's customers and collaborators include many federal, state and local agencies, companies and academic institutions. Partnerships are formed through cooperative agreements, licensing, technical assistance, centers of excellence, use of unique Sandia facilities, personnel exchanges and other mutually beneficial arrangements.





Sandia National Labs Facts-continued (2021)

Portfolio:

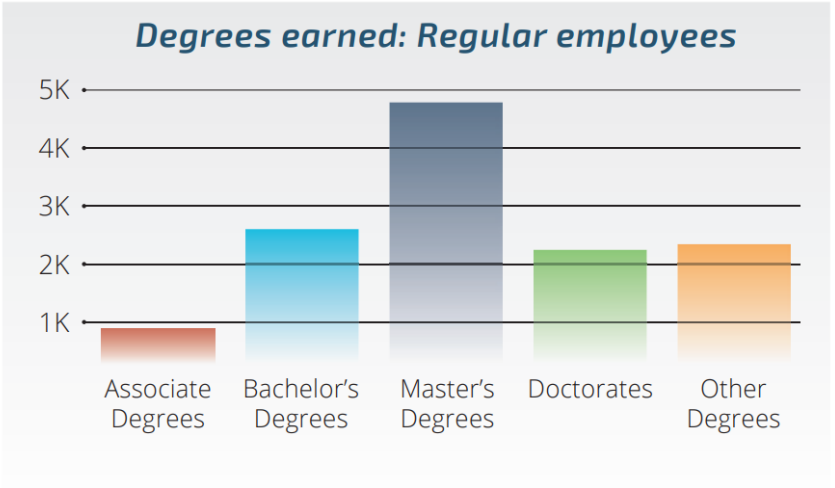
- Nuclear Deterrence, 59.7%
- Global Security, 16.7%
- National Security Programs, 13.8%
- Energy and Homeland Security, 7.3%
- Advanced Science & Technology, 2.6%

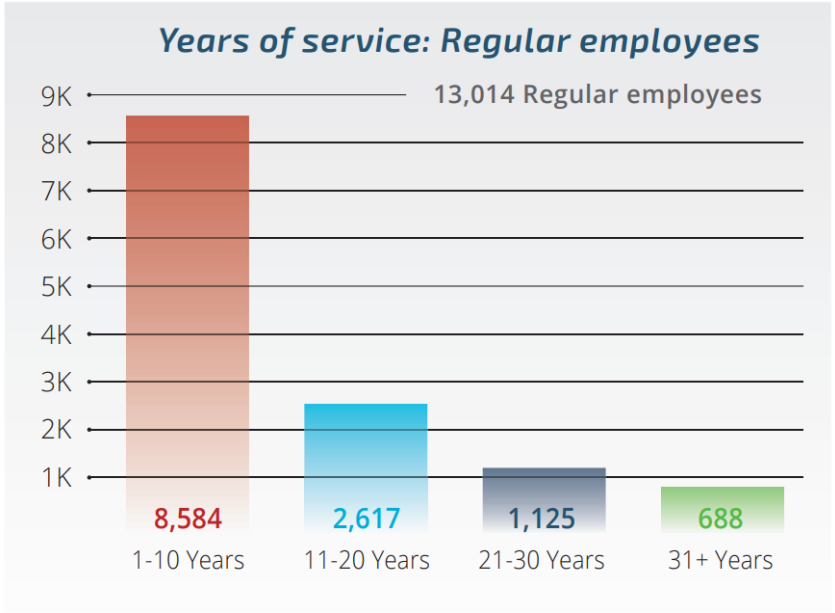
Research & development staff by discipline:

- Other engineering, 25%
- Computer science, 21%
- Mechanical engineering, 18%
- Electrical engineering, 16%
- Other science, 9%
- Cybersecurity, 6%
- Physics, 3%
- Chemistry, 1%

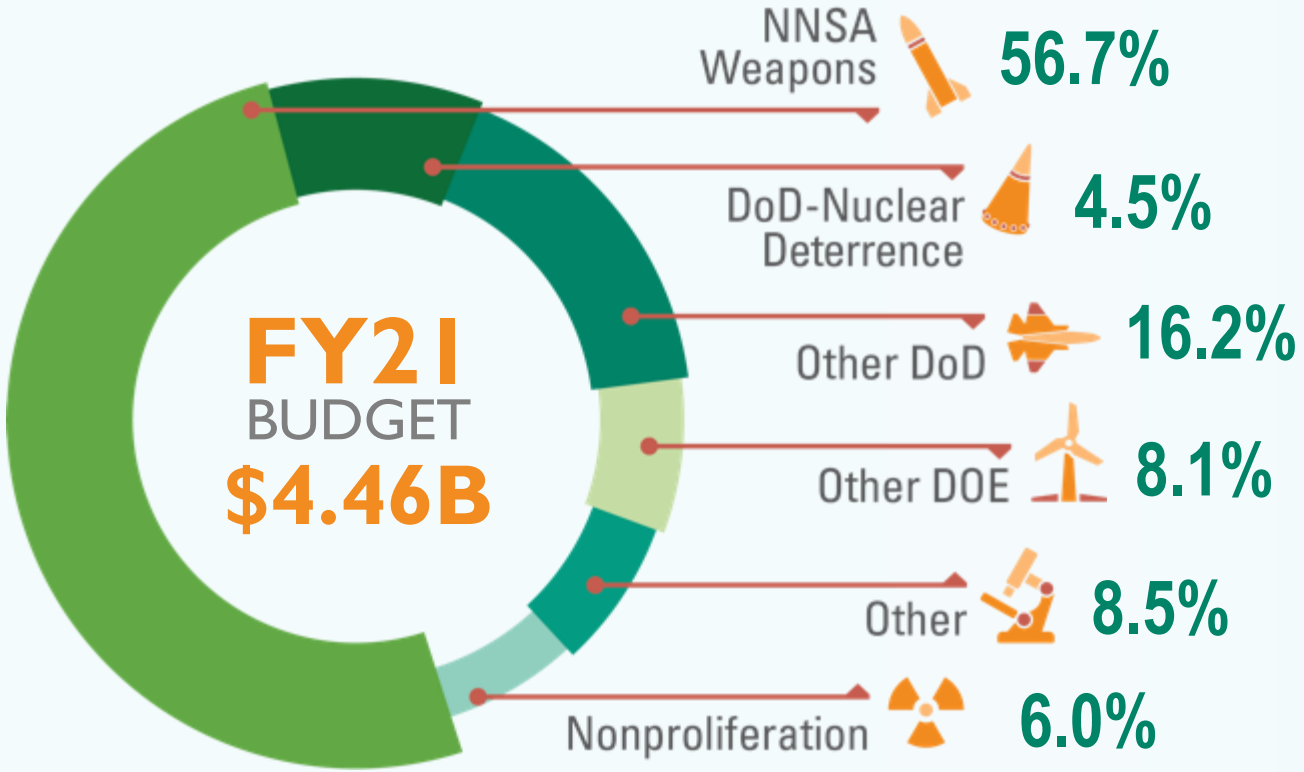
Sites:

- Albuquerque — 690 buildings and 13,734 acres
- California — 71 buildings and 410 acres
- Tonopah — 81 buildings and 3,520 acres
- Kauai and Maui — 48 buildings and 133 acres
- Leased facilities, all locations — 16 buildings and 2,713 acres





OUR BUDGET COVERS A BROAD RANGE OF GOVERNMENT AND OTHER WORK



OTHER

Department of Homeland Security
Other federal agencies | Nonfederal entities
CRADAs, licenses, royalties | Inter-entity work

DoD

Air Force | Army | Navy
Defense Threat Reduction Agency
Ballistic Missile Defense Organization
Office of the Secretary of Defense
Defense Advanced Research Projects Agency
Intelligence Community

OTHER DOE

Science
Energy Efficiency and Renewable Energy
Nuclear Energy
Environmental Management
Electricity Delivery and Energy Reliability
Other DOE

NONPROLIFERATION

NNSA/NA20 | State Department

INCLUSION AND DIVERSITY ARE STRATEGIC ADVANTAGES TO SANDIA

Sandia's leadership is dedicated to attracting, hiring, and retaining a diverse workforce, and building an inclusive environment

Sandia strives to increase the pool of diverse candidates

- Close collaboration with hiring managers
- Partnership with Sandia's Affirmative Action Employee Resource Groups to recruit, mentor, and support career development
- Expanded diversity outreach activities at targeted schools
- Recruiting at National Diversity Conferences

Part 2: A Career in Fire Science

Career Profile: Alexander Brown, Ph.D.

BS, Mechanical Engineering, 1995, Brigham Young University

MS, Mechanical Engineering, 1997, Brigham Young University

Ph.D., Mechanical Engineering, 2001, University of Colorado at Boulder

Graduate Internship, National Center for Atmospheric Research, Applied Technology Division, 1998-2000

Graduate Internship, National Renewable Energy Laboratory, National Bioenergy Center, 1999-2001

R&D Staff, Sandia National Laboratories, Fire Science and Technology Department, Engineering Sciences Center, 2002-present

BYU

University of Colorado Boulder

NCAR

NREL

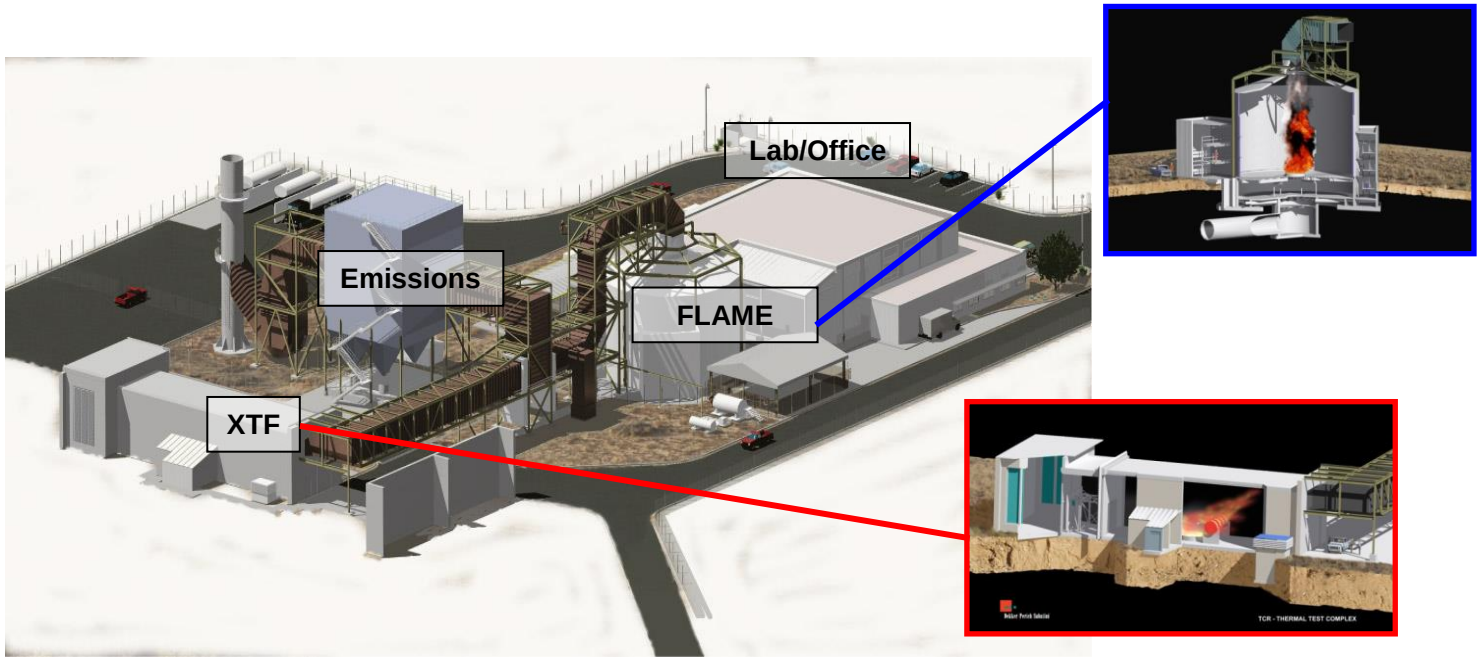
NATIONAL RENEWABLE ENERGY LABORATORY

Sandia National Laboratories

Fire Science and Technology

Department consists of 10 full-time staff, 3 post-docs, 21 total full and part-time researchers, plus 12 full-time technologists

Facilities include the burn site, the Thermal Test Complex (TTC)

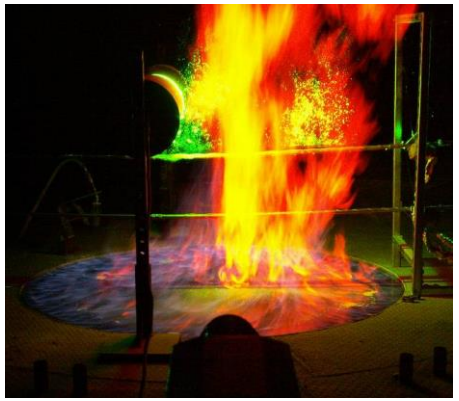


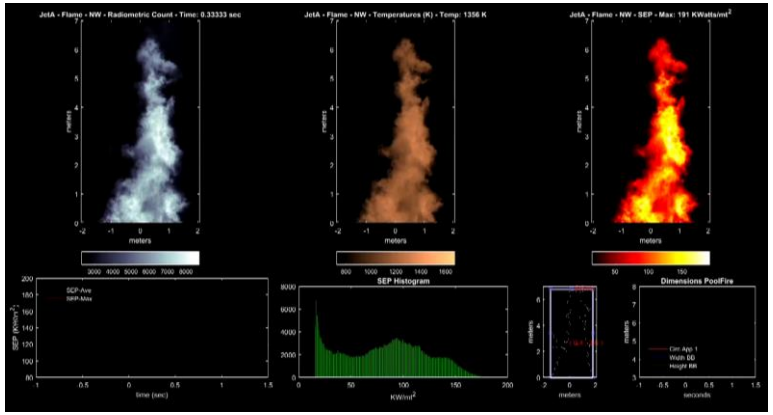
For more information, see http://tours.sandia.gov/ttc_info.html

Measurement Capabilities

Direct Thermal Measurements:

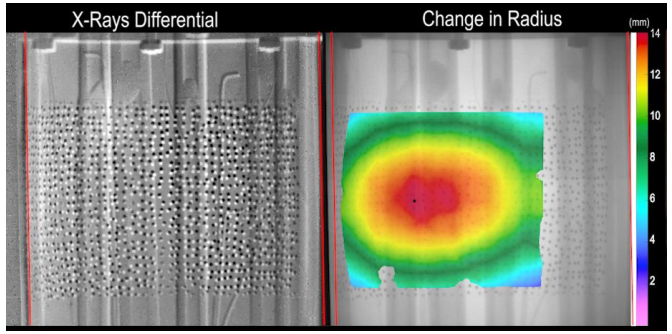
- Vis. IR and UV Cameras
- Heat Flux Gauges
- Thermocouples
- Black body calibration
- Furnaces
- X-ray thermometry
- Phosphor Thermometry
- Laser diagnostics (e.g., LIF, CARS)
- Residual Gas Analysis (MS/RGA)
- Reflectometry
- Spectrometry
- Pressure
- 3D scanning
- Rheology





Indirect Measurements (through partners):

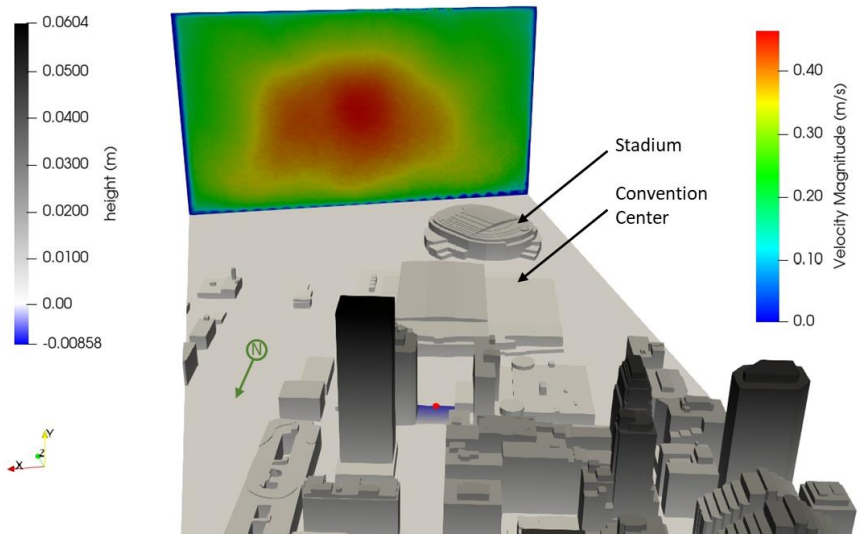
- GC/MS/ICP/FID/NMR detection
- FTIR
- SEM/TEM
- X-ray spectroscopy
- Accelerometry
- Velocimetry (various types)
- Aerosol sampling and measurement
- Digital image correlation
- DSC/TGA

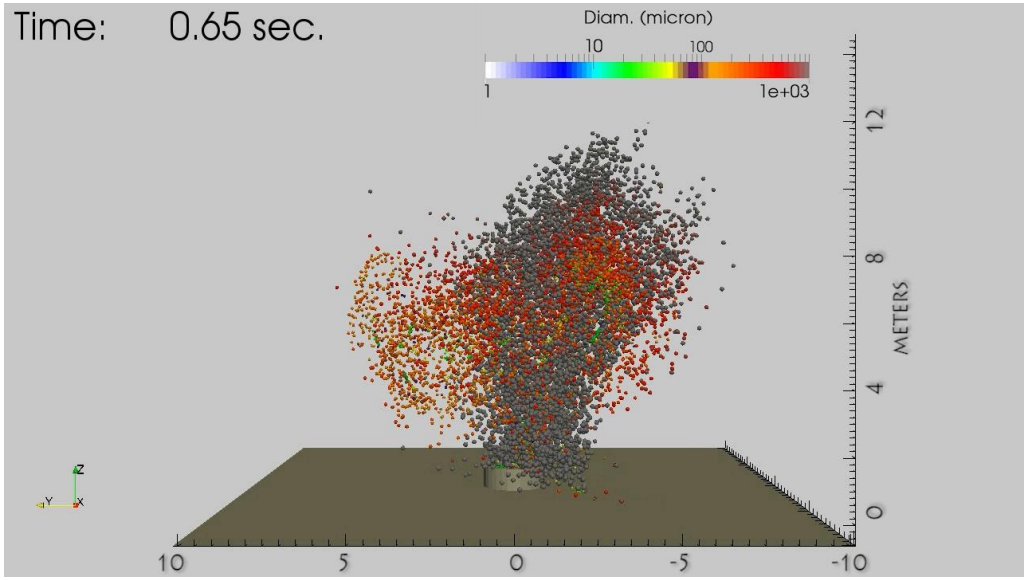


Sampling of Technical Projects

Highlighting several project activities:

- High heat flux ignition of solid materials
- Plasma spray simulations
- Tritium fire safety
- Pyrolysis oil and biochar
- Flow validation efforts:
  - He Plume
  - Oklahoma City plume release scenario
- Nuclear Facility Safety to Aircraft Impact





High heat flux ignition of solid materials

What happens when lightning, propellants, or high radiant flux ignites materials?

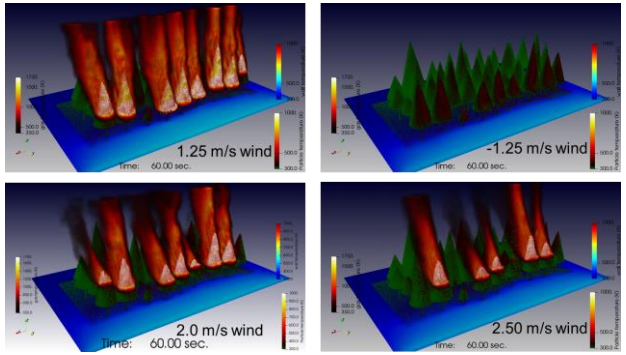
Most testing in the 1950s and 1960s suggest performance data for historical materials

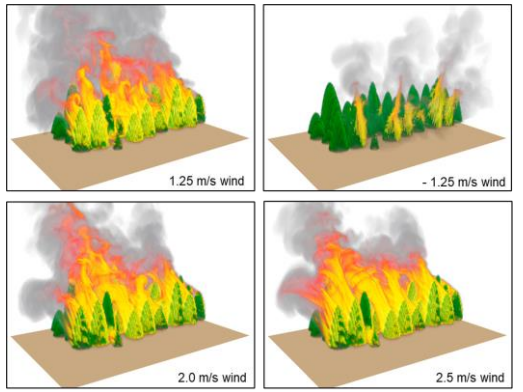
Recent data provides performance updates

Scale, shape, orientation were not historically explored and are important to the response

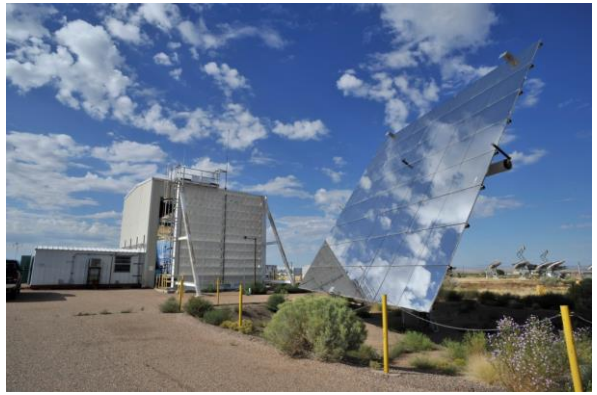
Historical data were not taken with 3D simulations in mind

Model Comparison between Sandia (left) and Los Alamos (right) models





Solar Energy R&D facilities provide platform for testing



Video available on youtube.com

Brown, A.L., Mendoza, H., Koo, E., Reisner, J., "A High Flux Forest Fire Scenario for Assessing Relative Model Accuracy for CFD Tools," for the Western States Section of the Combustion Institute Meeting, October 14-15, Albuquerque, NM.
Brown, A.L., Engerer, J.D., Ricks, A.J., Christian, J., Yellowhair, J., "Datasets for Material Ignition from High Radiant Flux," Fire Safety Journal 2020, https://doi.org/10.1016/j.firesaf.2020.103131

Plasma spray manufacturing

Plasma spray is a technique for applying a thin layer of a material (metal) onto another by heating the particle to melt in a plasma jet

Argon/Helium gas is ionized in a nozzle to generate energy to melt particles

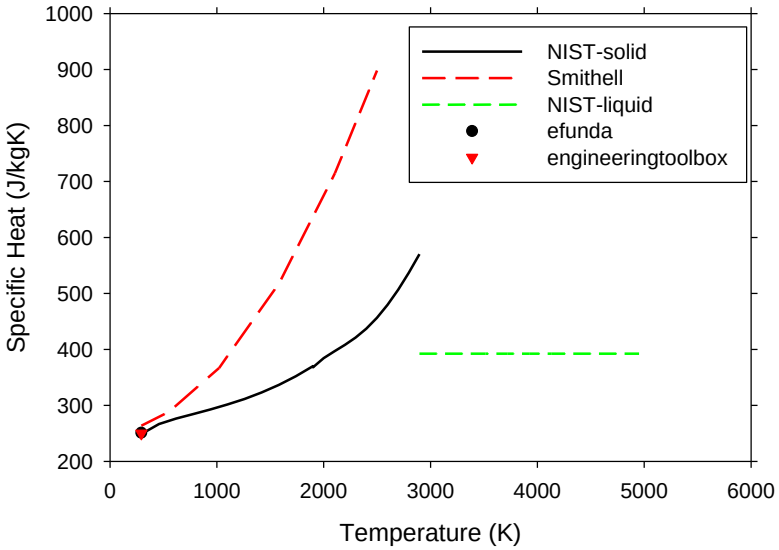
Particles impact part, and adhere, resulting in unique properties of engineered parts

Modeling helps interpret test operations, as data are hard to take in 10,000+°C environments

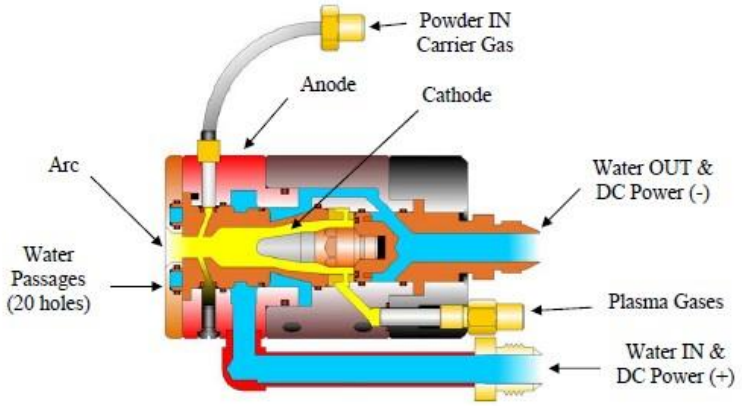
Key development: adaptation of fire modeling tool for plasma reactions

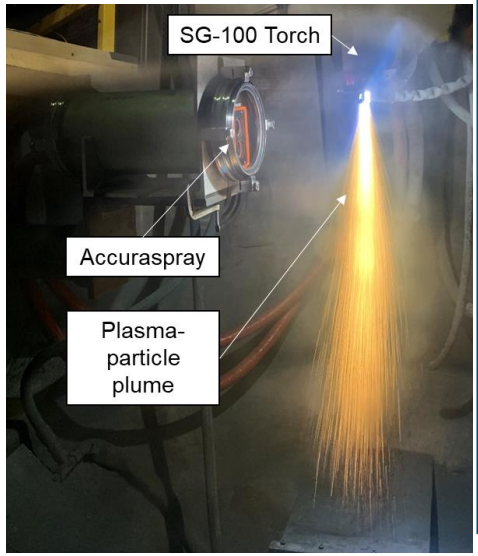
Properties for Molybdenum Discrepancy

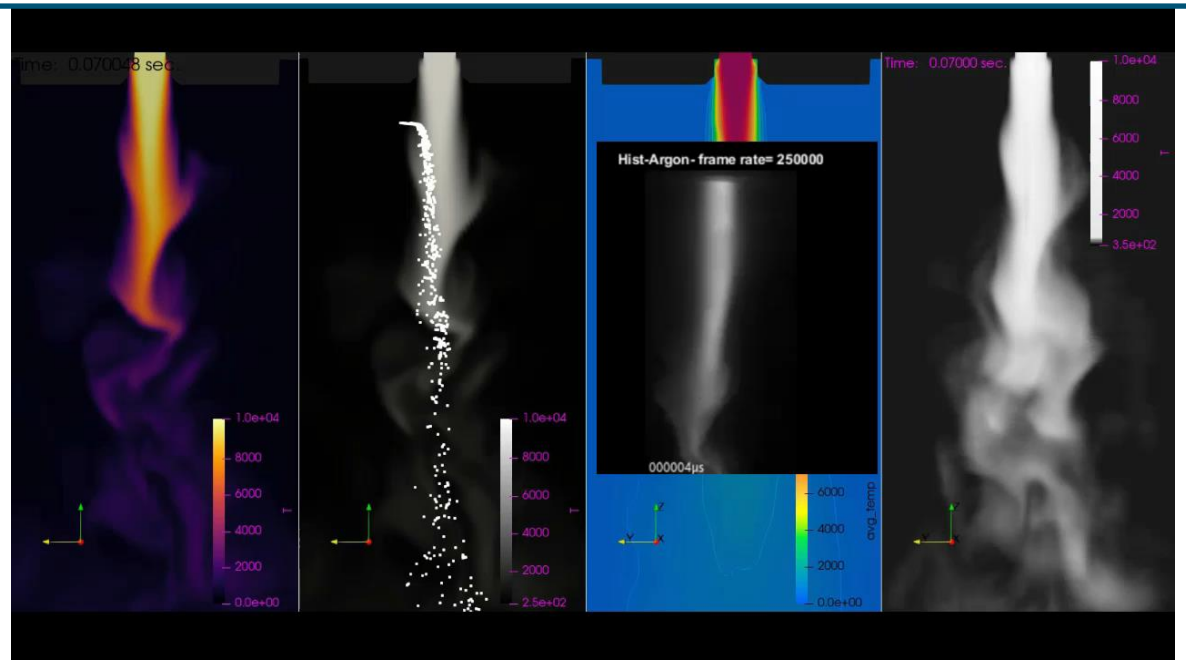
Despite wide publication, an error (large discrepancy) was found in thermal properties for Mo expressed in reference literature



Schematic and photograph of an SG-100 Plasma Torch







Tritium fire safety

Tritium (^3H) is a synthetic isotope of hydrogen

Small quantities are used throughout the DOE complex, and elsewhere

In T_2 form, not nearly as hazardous as T_2O or HTO, which is formed in a fire

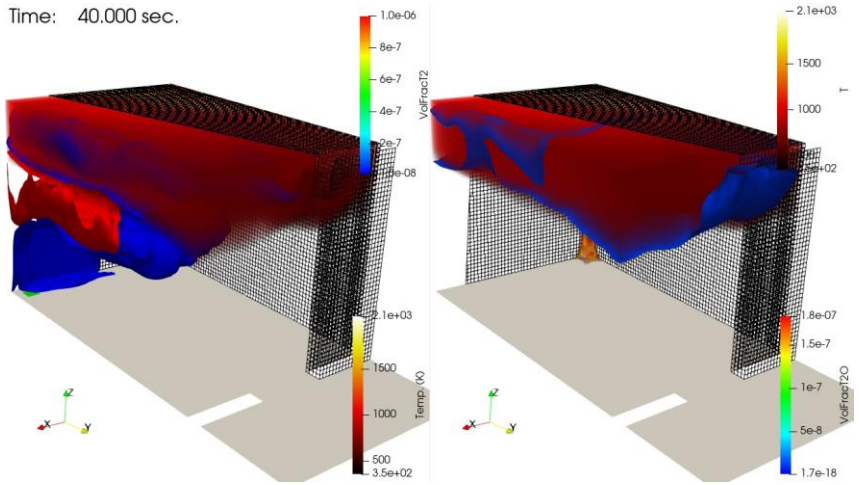
T_2 hazards do not permit testing, so credible simulations are needed to fill gaps where data do not exist

We are developing the tools and analysis to support safe operations

Typical tritium storage:

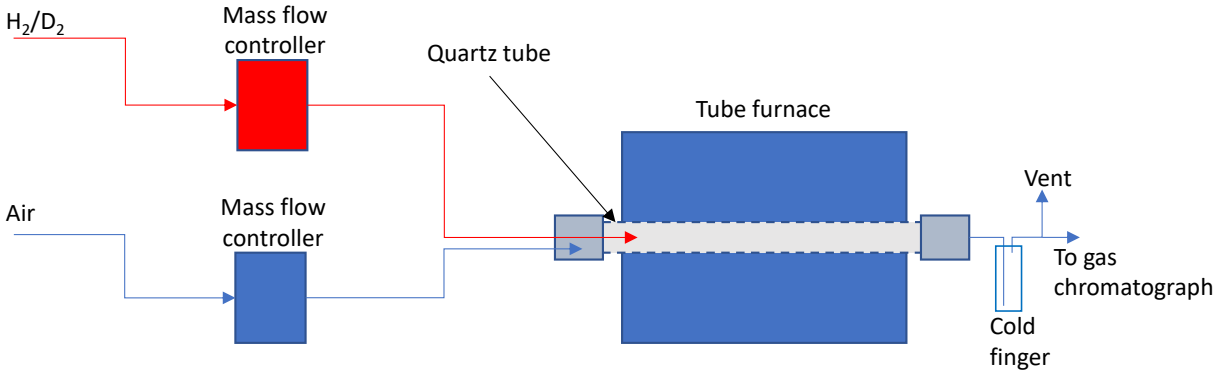
- Hydride beds
- Sub-atmospheric containers

Fires modeled using the ISO-9705 standard room to show tritium releases not directly in the fire have limited conversion to T_2O



T_2 Isocontours T_2O Isocontours

H_2 and D_2 used as surrogates for deriving oxidation reaction kinetics under relevant (low concentration) conditions for use in models and extrapolation to T_2 behavior



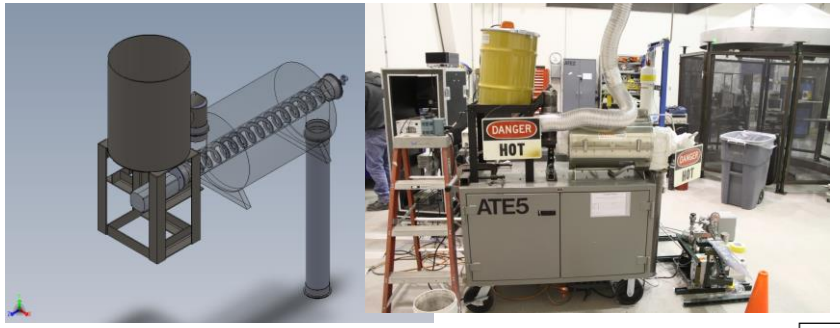
Brown, A.L., Shurtz, R.C., Takahashi, L.K., Coker, E.N., Hewson, J.C., and Hobbs, M.L., "Tritium Fires: Simulation and Safety Assessment," SAND 20222-4187, April 2022.

Pyrolysis oil and biochar

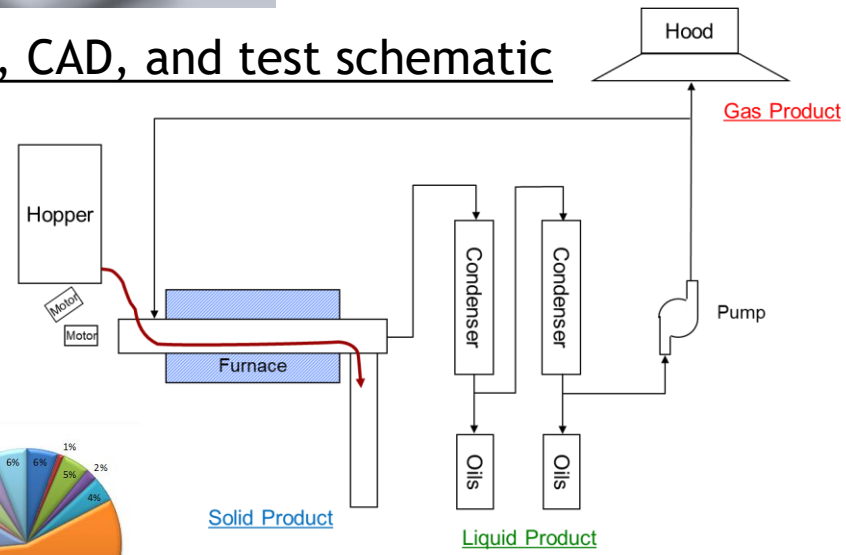
Pyrolysis oil is the condensable product of heating biomass (wood) in the absence of oxygen

Yields a liquid that can be processed as a substitute for liquid hydrocarbons

Solids are much like charcoal, can be used as soil supplement or fuel

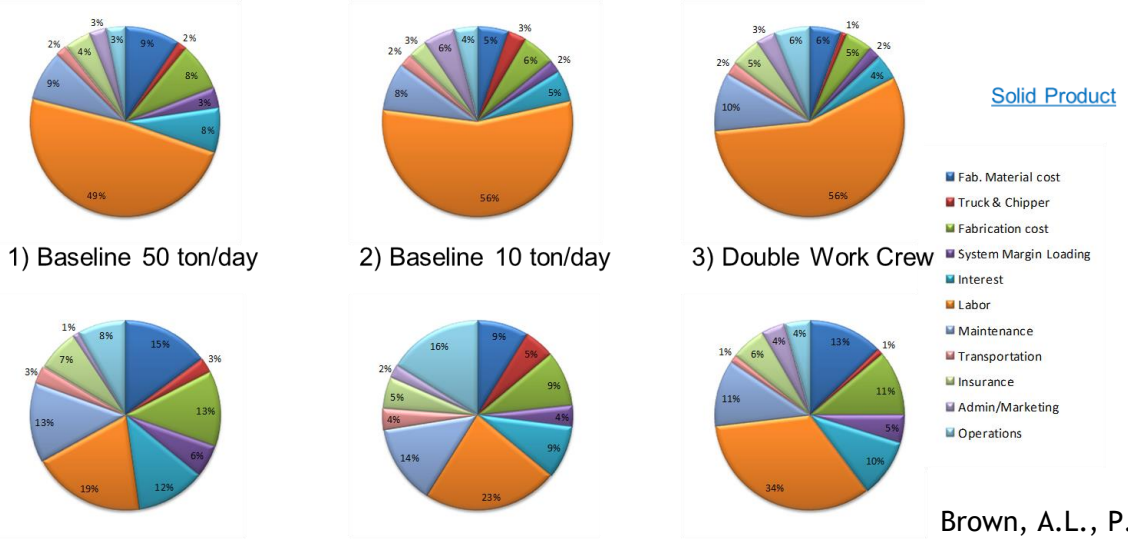


Photographic image, CAD, and test schematic



Video illustrating burning raw bio-oil

Technoeconomic Analysis of Scale-up



Brown, A.L., P.D. Brady, C.D. Mowry, T.T. Borek, "An Economic Analysis of Mobile Pyrolysis for Northern New Mexico Forests," Sandia Report SAND2011-9317.

He Plume

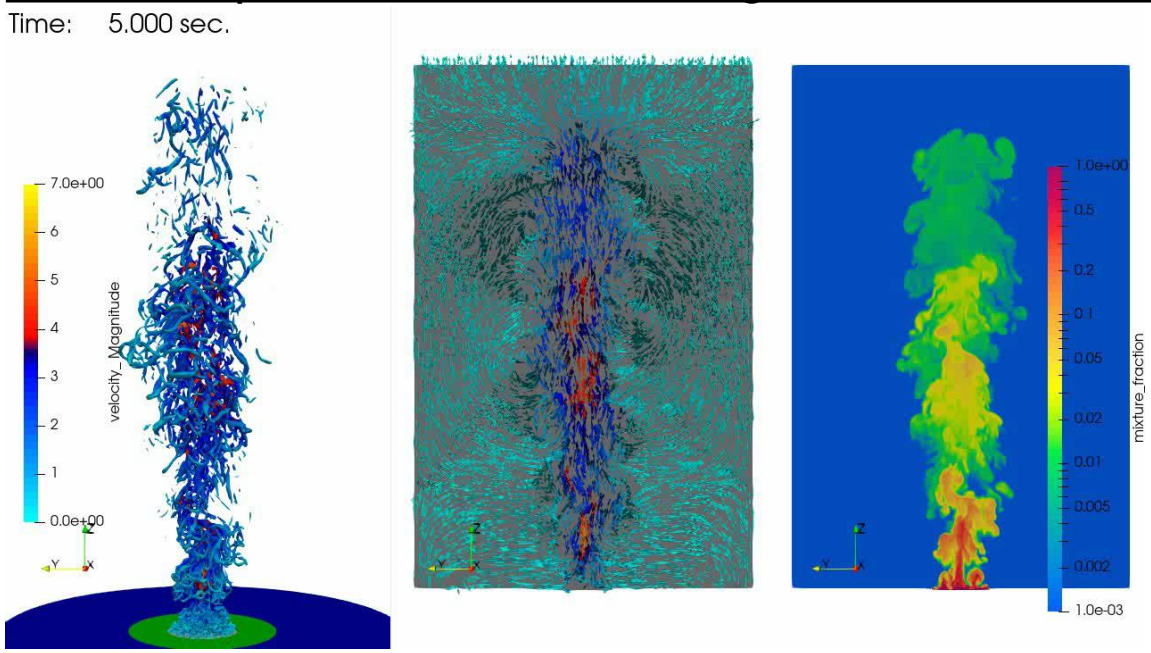
We take data to Validate simulations, as data is a true expression of the physical world

We compare our models to the data to understand the accuracy of the models

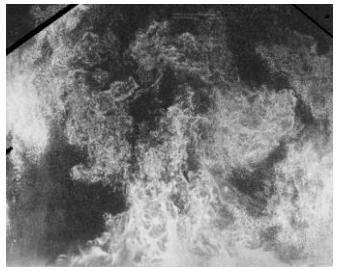
Validated models are relied upon when taking data is not possible

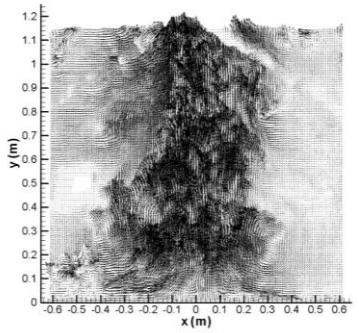
Here a He plume in the turbulent 1-m scale is used to characterize model accuracy

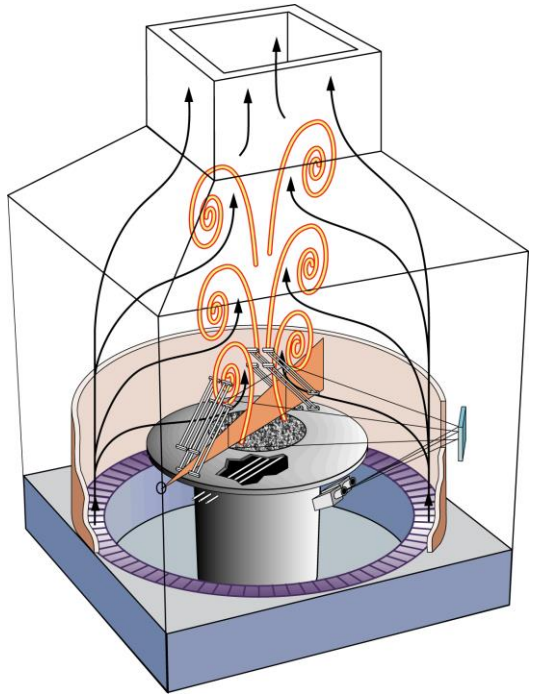
Simulated plume with SIERRA/Fuego, 40,000,000 nodes

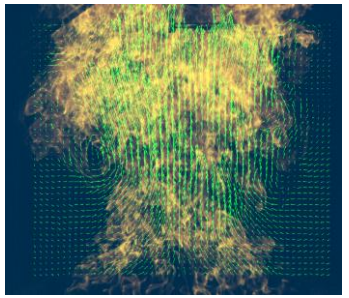


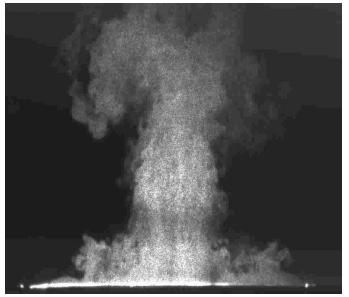
Photographic images and test schematic



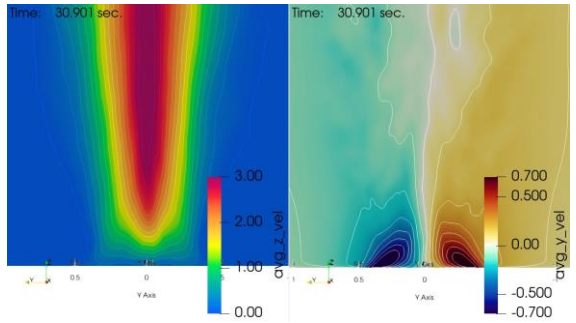


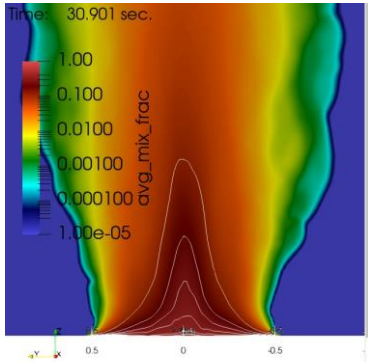


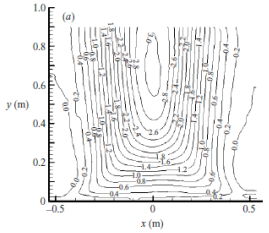


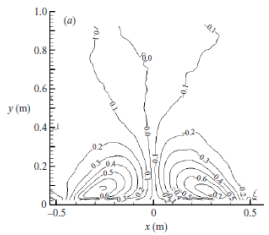


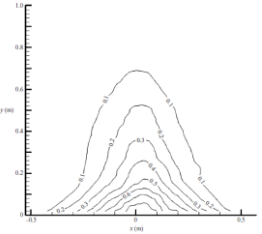
Planar Comparisons











Oklahoma City plume release scenario

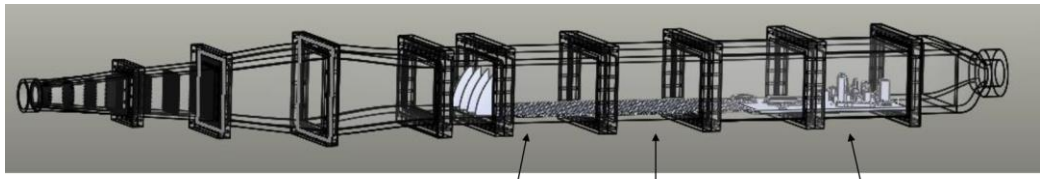
Validating simulations requires data

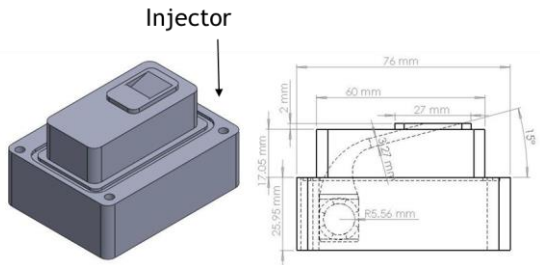
3D velocity and concentration data in fluids is very difficult to obtain

Using a medical MRI, we can extract 3D turbulent (Re>10,000) water flow data

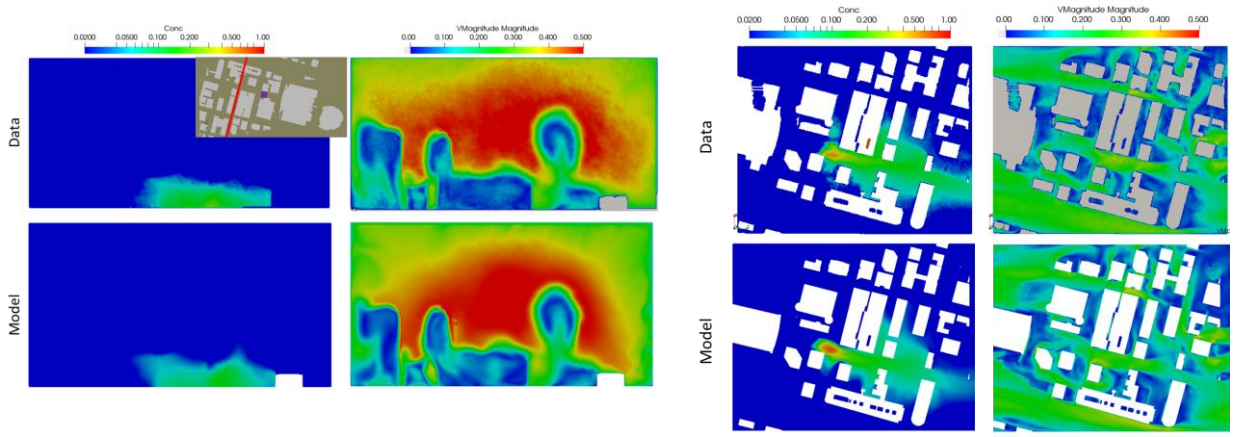
Detailed comparisons may be made to the high-fidelity dataset at 1:2500 scale

Geometries created with additive manufacturing





Full 3D comparisons made between model and data



Water Channel Validation Simulations
2018

Oklahoma City Scaled Scenario

LES Simulations with SIERRA/Fuego

In collaboration with

US Military Academy
Stanford University

3D data taken with MRC/MRV technique
0.8 mm resolution

Brown, A.L., M.D. Clemenson, M.J. Benson, C.J. Elkins, S.T. Jones, "An Urban Dispersion Inspired Scenario for CFD Model Validation," Vol. 120, Fire Safety Journal, 2021. 10.1016/j.firesaf.2020.103130

Nuclear Safety to Aircraft Impact

In the wake of the September 11, 2001 attacks, we were concerned with planes flying into critical infrastructure

How large is the fireball, how much fuel remains on the ground?

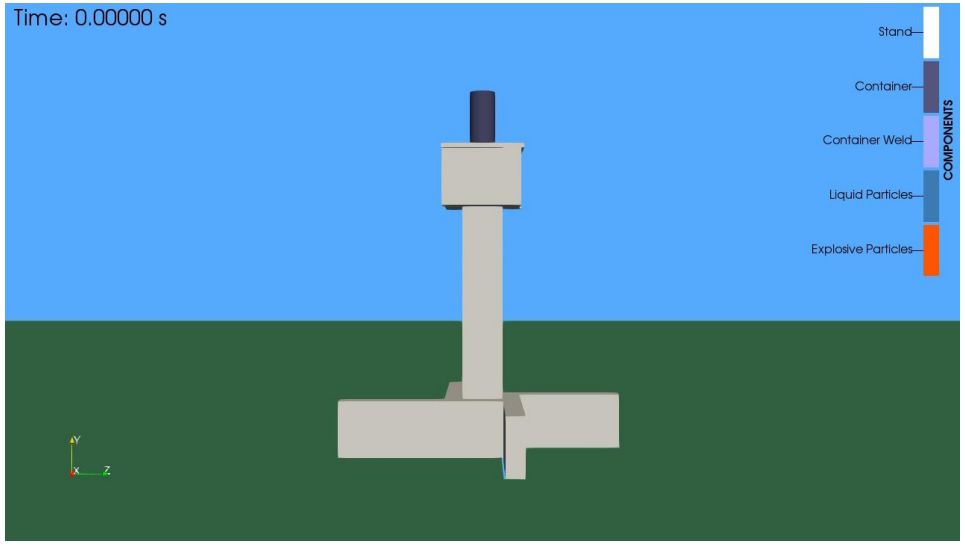
What happens to nuclear infrastructure if it is in the path?

Modeling and simulation provides assessment capability where experimental data do not exist

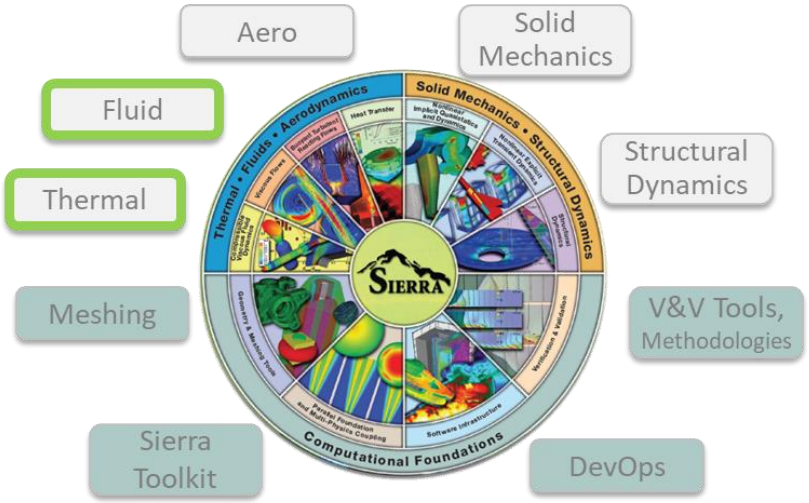
Sandia expertise leveraged to provide security and safety

Validation comparisons of models for water dispersion

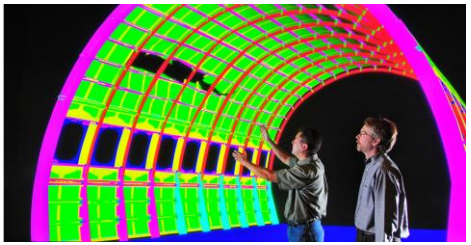
Structural and fluids codes coupled to predict response

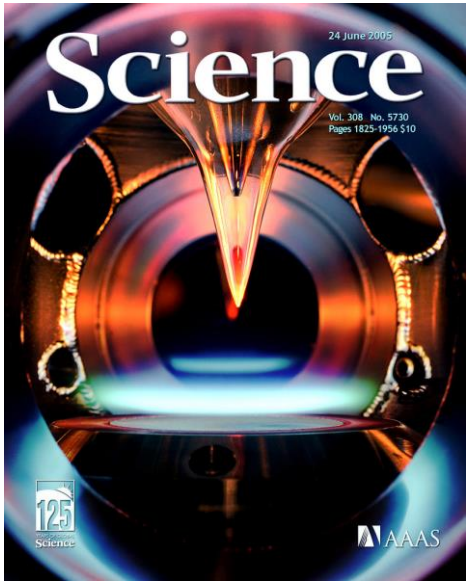


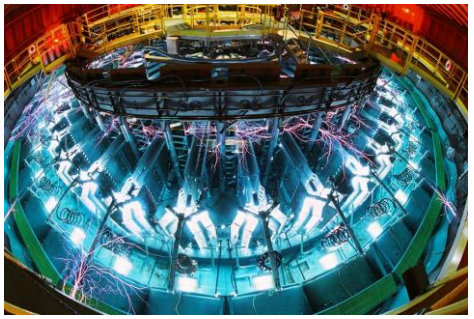
Common architecture and high performance computing enables unique predictions



Summary





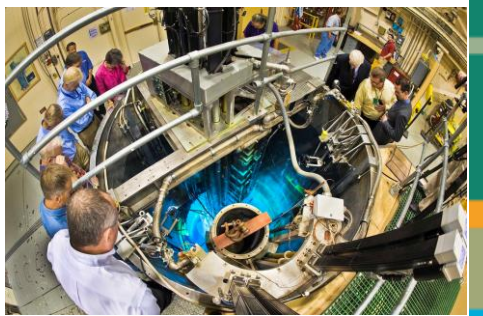


Sandia is an R&D laboratory specializing in national security

Opportunities exist for a rewarding technical career for outstanding candidates

To search for internship and career opportunities:

www.sandia.gov/careers



Extras